

CLEAN COPY OF AMENDED CLAIMS

1. (Four Times Amended) A method of fabricating a semiconductor device having a ferroelectric capacitor, comprising the steps of:

- forming an active device element on a substrate;
- forming an insulation film over said substrate to cover said active device element;
- forming a lower electrode layer of said ferroelectric capacitor over said insulation film;
- forming an amorphous PZT ferroelectric film on said lower electrode layer as a capacitor insulation film of said ferroelectric capacitor in the form of an amorphous film; and
- forming an upper electrode layer on said PZT ferroelectric film, wherein said step of forming said PZT ferroelectric film comprises a single annealing step, conducted after the step of depositing said PZT ferroelectric film, for crystallizing said PZT ferroelectric film, said single annealing step being conducted in an atmosphere having a composition set such that said atmosphere contains an oxidizing gas with a fraction of 1 to 20% in volume.

12. (Twice Amended) A method of fabricating a semiconductor device having a ferroelectric capacitor, comprising the steps of:

- forming an active device element on a substrate;
- forming an insulation film over said substrate to cover said active device element;
- forming a lower electrode layer of said ferroelectric capacitor over said insulation film, such that said lower electrode is formed on a layer containing Ti;
- forming a ferroelectric film on said lower electrode as a capacitor insulation film of said ferroelectric capacitor;
- crystallizing said ferroelectric film by applying a thermal annealing process in an O₂ atmosphere under a reduced total pressure in the range between 1 Torr and 40 Torr; and
- forming an upper electrode layer on said ferroelectric film.

14. (Twice Amended) A method of fabricating a semiconductor device having a ferroelectric capacitor, comprising the steps of:

- forming an active device element on a substrate;
- forming an insulation film over said substrate to cover said active device element;
- forming a lower electrode layer of said ferroelectric capacitor over said insulation film, said lower electrode layer being formed on a layer containing Ti atoms;
- forming a ferroelectric film on said lower electrode layer as a capacitor insulation film of said ferroelectric capacitor;
- crystallizing said ferroelectric film by applying a thermal annealing process in an atmosphere of an oxidizing gas with a fraction of 1 to 20% in volume; and
- forming an upper electrode layer on said ferroelectric film, wherein said step of crystallizing said ferroelectric film is conducted by supplying O₂ controlled to cause an oxidation in said Ti atoms reached a surface of said lower electrode from said layer part containing Ti atoms.

15. (Four Times Amended) A semiconductor device, comprising:

- a substrate;
- an active device element formed on said substrate;
- an insulation film provided over said substrate to cover said active device element;
- a lower electrode containing Pt provided over said insulation film;
- a PZT ferroelectric film provided on said lower electrode, said PZT ferroelectric film having a columnar microstructure extending from an interface between said lower electrode and said PZT ferroelectric film in a direction substantially perpendicular to a principal surface of said lower electrode, said PZT ferroelectric film generally having a <111> orientation and consisting of crystal grains generally having said <111> orientation and a substantially uniform grain diameter of less than about 200nm; and
- an upper electrode provided on said PZT ferroelectric film.

21. (Thrice Amended) A method of fabricating a semiconductor device having a ferroelectric capacitor, comprising the steps of:

forming an active device element on a substrate;

forming an insulation film over said substrate to cover said active device element;

forming a lower electrode layer of said ferroelectric capacitor over said insulation film such that said lower electrode is formed on a layer containing Ti;

forming an amorphous PZT ferroelectric film on said lower electrode layer as a capacitor insulation film of said ferroelectric capacitor in the form of an amorphous film;

crystallizing said amorphous PZT ferroelectric film by applying a thermal annealing process in an atmosphere containing a non-oxidizing gas and an oxidizing gas; and

forming an upper electrode layer on said PZT ferroelectric film, wherein said step of crystallizing said PZT ferroelectric film is conducted by setting the composition of said atmosphere such that said atmosphere contains said oxidizing gas with a fraction of 1 – 20% by volume, and wherein said method further comprises the step, after said step of crystallizing said PZT ferroelectric film, of oxidizing said ferroelectric film in an oxidizing atmosphere.